DOCUMENT RESUME

ED 400 523 CS 012 633

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TITLE Does Concept-Oriented Reading Instruction Increase Motivation, Strategies, and Conceptual Learning? Reading Research Report No. 66.
INSTITUTION National Reading Research Center, Athens, GA.; National Reading Research Center, College Park, MD.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE 96
CONTRACT 117A20007
NOTE 54p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Elementary Education; Grade 3; Grade 5; *Instructional Effectiveness; *Language Arts; *Reading Instruction; *Reading Motivation; Reading Research; *Reading Strategies; *Science Instruction
IDENTIFIERS *Concept Oriented Reading Instruction

ABSTRACT

The aims of concept-oriented reading instruction (CORI) are to increase motivation, strategies, and conceptual learning. To attain these aims, CORI classrooms are: conceptually oriented, observational, collaborative, and personalized, emphasizing strategies of searching, comprehending, integrating, and composing for audiences of peers. Two quasi-experimental studies compared CORI in language arts and science in grades 3 and 5 to traditional instruction on two performance assessments. In study 1, CORI students from three schools were higher in literacy engagement, conceptual learning, and conceptual transfer than traditional students, controlling three background variables. In multiple regressions, the variables of instruction, literacy engagement, and student background accounted for approximately 50% of the variance in conceptual learning. In study 2, CORI students were higher than traditional students in measures of literacy (reading and writing combined), language use, science, and social studies, but not in math, which was not taught in CORI. These experimental findings suggest that the principles of integrated teaching in CORI are responsible for increased literacy engagement and conceptual understanding in language arts and science. (Contains 49 references, and 7 tables and 5 figures of data.) (Author/RS)

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NRRC

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The work reported herein is a National Reading Research Project of the University of Georgia and University of Maryland. It was supported under the Educational Research and Development Centers Program (PR/AWARD NO. 117A20007) as administered by the Office of Educational Research and Improvement, U.S. Department of Education. The findings and opinions expressed here do not necessarily reflect the position or policies of the National Reading Research Center, the Office of Educational Research and Improvement, or the U.S. Department of Education.

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About the National Reading Research Center

The National Reading Research Center (NRRC) is funded by the Office of Educational Research and Improvement of the U.S. Department of Education to conduct research on reading and reading instruction. The NRRC is operated by a consortium of the University of Georgia and the University of Maryland College Park in collaboration with researchers at several institutions nationwide.

The NRRC's mission is to discover and document those conditions in homes, schools, and communities that encourage children to become skilled, enthusiastic, lifelong readers. NRRC researchers are committed to advancing the development of instructional programs sensitive to the cognitive, sociocultural, and motivational factors that affect children's success in reading. NRRC researchers from a variety of disciplines conduct studies with teachers and students from widely diverse cultural and socioeconomic backgrounds in pre-kindergarten through grade 12 classrooms. Research projects deal with the influence of family and family-school interactions on the development of literacy; the interaction of sociocultural factors and motivation to read; the impact of literature-based reading programs on reading achievement; the effects of reading strategies instruction on comprehension and critical thinking in literature, science, and history; the influence of innovative group participation structures on motivation and learning; the potential of computer technology to enhance literacy; and the development of methods and standards for alternative literacy assessments.

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Universities of Georgia and Maryland
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Abstract. *The aims of concept-oriented reading instruction (CORI) are to increase motivation, strategies, and conceptual learning. To attain these aims, CORI classrooms are: conceptually oriented, observational, collaborative, and personalized, emphasizing strategies of searching, comprehending, integrating, and composing for audiences of peers. We conducted two quasi-experimental studies comparing CORI in language arts and science in grades 3 and 5 to traditional instruction on two performance assessments. In Study I, CORI students from three schools were higher in literacy engagement, conceptual learning, and conceptual transfer than traditional students, controlling three background variables. In multiple regressions, the variables of instruction, literacy engagement, and student background accounted for approximately 50% of the variance in conceptual learning. In Study II, CORI students were higher than traditional students in measures of literacy (reading and writing combined), language use, science, and social studies, but not in math, which was not taught in CORI. These experimental findings suggest that the principles of integrated teaching in CORI are responsible for increased literacy engagement and conceptual understanding in language arts and science.*

STUDY I
Introduction

It has been emphasized from a variety of theoretical perspectives that reading is inherently a meaning-making process (Barr, Kamil, Mosenthal, & Pearson, 1991). However, the nature of meaning constructed from text may vary dramatically from lower-order, rote, verbatim meanings to higher-order, interpretive, and conceptual meanings. As students read, they gain important facts and bits of information. At the same time, motivated readers construct explanations and attempt to account for the particular elements they have comprehended. In this paper, we suggest that when students are gaining conceptual knowledge from text they are forming higher-order principles that explain and account for particular features of text they have understood. Forming these principles is effortful, requiring a broad repertoire of cognitive strategies that can be flexibly applied.

These complex constructions of meaning depend on motivations for understanding (Paris & Turner, 1994). Acknowledging the importance of cognitive capabilities, such as using prior knowledge (Anderson & Pearson, 1984), activating cognitive strategies (Collins-Block, 1992), and following metacognitive directives (Baker & Brown, 1984), we believe that including the role of motivational variables is valuable (Pintrich & Schrauben, 1992; Wigfield & Eccles, 1992) in accounting for expertise in reading and writing. Not only is motivation expected to influence the amount and breadth of students' reading activities (Wigfield & Guthrie, 1995), but also motivation is likely to enhance the construction of higher-order meanings from text.

Positive motivational dispositions toward using strategies and developing explanations, in contrast to merely finishing tasks and recording elemental bits of information, are necessary to the acquisition of explanatory understanding. Consequently, we agree with Bereiter and Scardamalia (1989) that these motivations and dispositions should become goals of instruction. In this paper, we examine the relationships of strategies, motivations, and conceptual learning, and we ask whether instructional contexts influence the development of literacy engagement (i.e., motivated strategy-use) and conceptual learning (see Figure 1).

Perspectives on Conceptual Learning

At least three perspectives on conceptual learning can be identified in the current literature. The first perspective emphasizes the enrichment of mental structures from a constructivist perspective (Glynn, Yeaney, & Britton, 1991). For example, Chi, DeLeeuw, Chiu, and Lavancher (1994) reported that higher levels of conceptual knowledge about the biology of the human heart were associated with enriched mental models. These models contained a relatively large number of features, and a systemic, dynamic sense of how the heart operates. Conceptual learning was associated with an increased number of features, completeness of the system, and intersection among the heart's functions. In addition to showing that individual differences between learners could be described in terms of different levels of mental models, Chi et al. (1994) showed that asking students to explain individual facts and propositions as they read a text enhanced conceptual learning. Consistent with this view, Mayer (1992) stated that conceptual knowledge can be described as a runable mental model. His studies illustrated that conceptual understanding of a system such as a bicycle pump consists of knowing the parts, the action of the parts, and the principles that govern those actions including friction, resistance, and motion. Students who learned these principles were able to answer high-level questions and solve problems better than students who did not possess such a dynamic mental model.

The enrichment view of conceptual learning from text is also espoused by diSessa (1993) who argued that learning the principles of physics entails the development of a sense of how systems work. He stated that "understanding evolves toward compactness involving a few principles that are as general as possible"

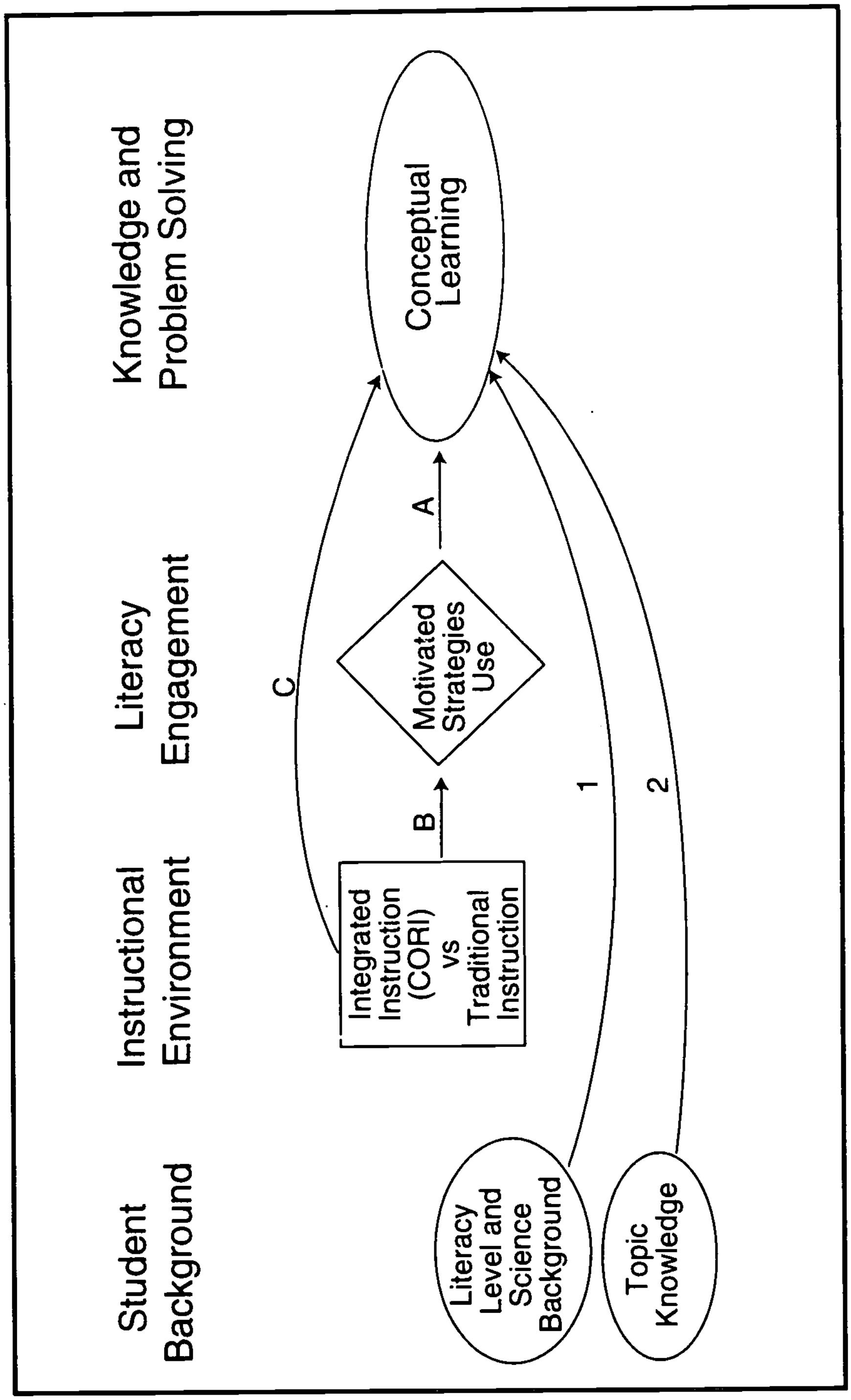

Figure 1. Promoting conceptual learning through literacy engagement and integrated instruction.

(p. 190). He concluded that "cultivating the sense of mechanism (how systems work) can help students to develop adequate scientific models of situations" (p. 206). Understanding biology can also be construed as conceptual learning. In a review of research on knowledge representation, Alexander, Schallert, and Hare (1991) concluded that as students become more knowledgeable in a subject, their understanding is increasingly organized around fundamental principles. These principles are associated with rules of evidence and procedures for gathering and testing evidence. Both diSessa (1993) and Alexander et al. (1991) underscore the view that conceptual learning consists of generalizations that embrace particular features, structures, and functions.

Researchers who examine children's conceptual development concur with this perspective. For example, Keil (1989) documents that a characteristic-to-defining shift describes the development of concepts of everyday life. Young children shift from evenly weighing several features of an object such as an island, to placing heavy emphasis on one or two primary features and fundamental organizing dimensions. For instance, an island has trees, land, animals, and water; but the defining feature of an island is that it is surrounded by water. This shift is confirmed by Metz (1995) who argues that biological concepts depend on classification based on defining features, but higher-order principles such as photosynthesis rely on principled organization of structures, functions, relations, and their change across time. As Reif (1990) says, the concept is a set of principles or rules that enable the person to understand specific properties, the values of those properties, and how factors influence them and their interrelationships. A variety of techniques now exist to represent those enriched knowledge structures (Jonassen, Beissner, and Yacci, 1993).

A second perspective on conceptual learning emphasizes restructuring of existing information. Vosniadou (1994) presents a vivid illustration of the restructuring process. She documents that across grades 1–6, children restructure their knowledge of the earth's shape. Most younger students believe a dual earth theory in which the earth is round but you can fall off of it if you walk far enough. By age 8, one-third of the students believe the earth is a sphere; by age 10, two-thirds believe the earth is a sphere that peoples on all sides can occupy. Conceptual learning, in this perspective, entails the revision of one form of explanatory understanding into a different form of understanding. The particular facts and features of the concept change little, but the principle of explanation changes substantially.

Strike and Posner (1985) describe the process of restructuring. They state that the process consists of "dissatisfaction within an existing conception, followed by finding a new conception understandable, leading to an initial belief in its plausibility, and concluding with the belief that the new conception is ultimately fruitful" (p. 221). Extensive research on perspective was reported in a review by Chinn and Brewer (1993). As Smith (1991) noted, the problem of conceptual change is that "students have to change an idea they had initially" (p. 49). The restructuring perspective underscores the need to challenge old knowledge and accommodate it to fit new data.

The third perspective defines conceptual learning as the cumulative increase of information. In studies of knowledge acquisition from text (Carroll & Freedle, 1972), free-recall tasks are used to measure students' recollection of text-based propositions, irrespective of the higher-order or lower-order nature of that meaning. In these studies, conceptual learning was represented on a continuum from low to high information levels. In science education, too, this cumulative perspective is found. For example, Novak and Musonda (1991) reported that concept maps (graphic organizers) can document learning by showing an increase in the number of nodes and the number of links between the nodes. These increases are characterized as conceptual, or meaningful, learning. Spoehr (1994) reported that the knowledge of science concepts can be represented as a concept map of nodes and links and that the number of these elements can be shown to increase with appropriate instruction. Confirming this perspective, Krajcik (1991) argued that learning concepts of chemistry can be represented in the form of increasingly elaborated concept maps.

The distinction between the cumulative perspective and the enrichment view is that the cumulative orientation does not underscore higher-order principles. In the cumulative perspective, the nodes and links are given equal weight. Qualitative shifts in types of knowledge are not recognized. The cumulative perspective differs from the restructuring perspective by emphasizing the accretion of information rather than revision of existing knowledge formations.

In this report, we adopt the enrichment perspective in which knowledge increases in several respects. As students enhance their conceptual understanding, they gain command of more elements, features, and functions in a particular domain. Learners form principles to organize these particulars into relationships. At the highest levels of conceptual understanding, students possess interrelated, explanatory principles for phenomena and events. They gain the ability to coordinate theory and evidence, and they can express the interplay between them. See Figure 1 for a schematic of the variables in this study.

Relations of Strategies and Motivations to Conceptual Learning

Learning concepts from text is strongly facilitated by complex cognitive strategies. As many investigators have shown, gaining knowledge from text depends on problem finding (Collins-Block, 1992), applying prior knowledge (Anderson & Pearson, 1984), searching for information (Armbruster & Armstrong, 1993), comprehension strategies (Dole, Duffy, Roehler, & Pearson, 1991), self-monitoring (Baker & Brown, 1984), and strategies suitable for different genre (Graesser, Golding, & Long, 1991).

Although these cognitive strategies are helpful in learning concepts from text, such strategies depend heavily on intrinsic motivation. In a review of motivation literature, Pintrich and Schrauben (1992) documented the high correlations between intrinsic motivations and strategy use. Including interest in the content, wanting to learn for its own sake, and feeling immersed in the literacy task (Reed & Schallert, 1993), various intrinsic motivations are associated with more frequent and appropriate use of higher-order cognitive strategies. These findings were confirmed experimentally by Graham and Golan (1991) who showed that more meaningful tasks produced higher intrinsic motivations and the use of more complex learning strategies than less meaningful tasks. Unfortunately, none of these investigations examined whether the more motivated students who were using relatively higher numbers of strategies were, in fact, gaining higher levels of conceptual knowledge. We do not know from these studies whether conceptual learning was enhanced by motivation. This literature does confirm, however, that strategies that are traditionally associated with conceptual learning are strongly associated with intrinsic motivation.

One motivational variable (text-based, situational interest) has been related to conceptual learning. As defined by Schraw, Bruning, and Svoboda (1995), situational interest is "common across individuals, short-lived and elicited within a particular context" (p. 1). Situational interest contrasts with personal interest that is "unique to the individual, topic specific, long-lasting, and exits before encountering a particular text" (p. 1). Hidi and Anderson (1992), and Shraw et al. (1995) have documented that students who display high situational interest in a particular text will show relatively elaborated understanding of concepts within the text. Unfortunately, neither of these studies controlled for amount of prior knowledge about the topic, which is arguably associated with situational interest. However, Schiefele (1992) succeeded in controlling the amount of prior knowledge and documented the effect of situational interest on conceptual knowledge gain from text. Although these studies document that situational interest is a factor in conceptual learning, they do not relate personal interest and more permanent intrinsic motivations to conceptual learning. There is a need, therefore, to relate conceptual learning, strategy use, and intrinsic motivations to each other.

Effects of Educational Context on Literacy Engagement and Conceptual Learning

In a valuable review of integrated instruction, Lipson, Valencia, Wixson, and Peters (1993) reported that integrated curricula are usually claimed to make learning meaningful, and this meaningfulness is thought to increase conceptual knowledge. Integrations of different disciplines (e.g., reading with writing, or language-arts with social studies) are claimed, furthermore, to accelerate the development of metacognitive awareness and to foster positive attitudes toward literacy. Similar claims are made by other investigators who have designed and implemented integrated instruction in science and language arts (Blumenfeld, 1992; Brown, 1992). However, relatively few investigators have attempted to collect information regarding children's learning and development in integrated instructional environments. Whether or not students learn is a significant issue, according to Brophy and Alleman (1991) who caution that integrated instruction may not do justice to the separate disciplines combined. We concur that trivial forms of thematic teaching may undermine rather than embellish the learning of conceptual themes and fundamental literacy processes.

Characteristics of the classroom context and motivation for literacy have been reported by Turner (1995) in a study of first graders and Hooper (1994) in an investigation of third, fourth, and sixth graders. After observing primary classrooms intensively, Turner (1995) reported that motivation for literacy was affected by two types of classroom tasks. Open tasks, in which students experienced relatively high levels of choice, challenge, control over learning, and collaboration with other students, were associated with high reports of intrinsic motivation. In relatively closed tasks, the teacher determined the learning activities (low choice), tasks were simplified and rote (low challenge), the program defined the tasks (low control), and students worked individually (low collaboration). In closed tasks, students reported less intrinsic motivation, less effort, and lower persistence.

Confirming the importance of challenge, Hooper (1994) reported that when literacy tasks contained an expectation for higher-order activity, such as analyzing books, students were more likely to be intrinsically motivated than when tasks were simpler, at the word and sentence level. Intrinsic motivation, which referred to involvement and enjoyment, was apparent on 72% of complex tasks; whereas extrinsic motivation, which referred orientation to task completion, occurred for 72% of the simple tasks. These findings generalized across grades 3–6 and included learning disabled as well as mainstreamed students. These two investigations reported a prominent association between task structure and intrinsic motivation in extant classroom contexts.

In addition to the suggestion that challenging, personalized, collaborative classrooms enhance motivation for learning, there is a growing consensus that these contexts enhance conceptual understanding. For example, Blumenfeld (1992) and Perkins (1992) contend that integrated curricula can enable students to gain deep understanding of content. Unfortunately, there is very little evidence to support this claim. Blumenfeld and Meece (1988) and Brown (1992) show that when conceptual themes are emphasized, rather than activities, tasks, or procedures, students gain higher-order knowledge relatively well. We concur and extend the proposition to literacy engagement and conceptual learning. We propose that enhancing literacy engagement through concept-oriented reading instruction (CORI) can enhance students' literacy engagement which will increase their ability to learn high-level concepts. To examine this proposition, we conducted two studies in which we compared CORI students to control groups. The following questions guided the study.

1. Does literacy engagement increase conceptual learning when "background" factors of science background, literacy level, and topic knowledge are controlled?
2. Does CORI increase literacy engagement when background factors are controlled?
3. Does CORI increase conceptual learning when literacy engagement and background factors are controlled?
4. How do students in grades 3 and 5, who receive CORI, compare to other students in literacy engagement?
5. How do students in grades 3 and 5, who receive CORI, compare to other students in conceptual learning?

6. How does conceptual transfer relate to conceptual learning and literacy engagement in grade 5 and grade 3 when background factors are controlled?
7. What effect does CORI have on comprehension of informational and narrative text?
8. What instructional principles distinguish CORI and traditional instruction?

Method

Participants

Teachers and schools. Three schools on the border of a large metropolis in the mid-Atlantic states participated in this study. Each school had multicultural populations consisting of approximately 50% African-American, 25% Caucasian, 15% Hispanic, and 10% Asian. Two of the schools were designated as Chapter 1 and one school had a mainstream program for orthopedically disabled students. The schools were nominated by the district supervisor of reading as likely to benefit from an integrated curriculum for low achieving students, and the principals were pleased to participate after being asked by the project director. The teachers were volunteers from the schools, and were approved by the principal and the project director. They were not nominated as exemplary instructors, but were selected as typical, experienced elementary teachers.

Classrooms and students. Third-grade classrooms in all schools were self-contained, with approximately 30 students in each. Due to the transitory population, a total of approximately 20 fifth-grade students in each of two classrooms completed the year of CORI. A total of 20 fifth-grade students from each of two basal classrooms was used as comparison students. Approximately 25 third-grade students in each of three classrooms completed the year of CORI; approximately 75 students in third-grade basal classrooms were used for comparison. The students consisted of approximately equal number of boys and girls with 5–6 special education students mainstreamed into each classroom. Learning disabled, orthopedically disabled, and emotionally disturbed learners were included in the instruction and assessments. Low achievers from transitory home backgrounds were also included.

Design

This quasi-experiment consisted of two instructional conditions, CORI and traditionally organized basal and science instruction. CORI was implemented in five classrooms, 3 third-grade and 2 fifth-grade classrooms. Comparison classrooms within each school were selected for comparison to the CORI classrooms. These classrooms were selected on the basis of comparable students, teachers, and school settings. The measures of literacy and engagement including the performance assessment, questionnaires, and teachers' ratings were administered to all 10 classrooms. The design was a post-measure only in which the performance assessment and questionnaires were administered in the first half of April to all students. Teachers' observational ratings of students' levels of English/language arts and science backgrounds were obtained in the fall of 1994 as statistical controls.

Instructional goals. The CORI and traditional programs were both directed toward similar goals for English/language arts and science. These goals were approved by the district, school, and project participants. In English/language arts, the objectives consisted of interpreting stories, comprehending expository texts, locating and integrating information from multiple texts, summarizing, self-monitoring, writing personal narratives, composing informational reports, and writing poetry. In science, the common goals included understanding the life cycles of plants and animals, describing important adaptations of animal species, understanding cycles of weather and seasons, collecting data, interpreting graphs and tables, and interpreting data from classwide projects. More complex higher-order goals were adopted for fifth-grade than for third-grade students; and instruction was adjusted to meet the needs of all learners, including approximately five students in each grade 3 CORI classroom who entered the year reading at a 1.5 grade level. These goals and the instruction are presented more fully in Guthrie, McCann, Hynd, and Stahl (in press).

Concept-oriented reading instruction. The framework for CORI included four phases: observe and personalize, search and retrieve, comprehend and integrate, communicate to others. To implement this framework, teachers first identified a conceptual theme for instructional units to be taught for 16–18 weeks in the fall and spring. The themes selected by third-grade teachers consisted of the adaptations and habitats of birds and insects. The third-grade units in the spring consisted of weather, seasons, and earth formations. Fifth-grade units in the fall related to life cycles of plants and animals, and the spring units emphasized earth science, including the solar system and geological cycles.

At the beginning of each unit students engaged in observation and hands-on activities both outside and inside the classroom. Third- and fifth-graders participated in such activities as collecting and observing crickets, constructing spider webs, dissecting owl pellets, and building weather stations. Within each activity, students personalized their learning by composing their own questions as the basis for observing, reading, and writing. Student questions included a structural focus, such as, "How many types of feathers does a bird have?" Then conceptual questions, such as "Why does that bird have such a long beak?" evolved as students attempted to explain the phenomena they had observed. These questions generated opportunities for self-directed learning. Students chose their own subtopics, found particular books, selected peers for interest-based activities, and constructed their goals for communicating to others.

The second phase of the CORI framework consisted of searching and retrieving information related to the student's questions. Students were taught how to use the library, find information books, locate information within expository texts, and utilize a diversity of community resources. In addition, direct strategy instruction was provided to help students integrate across information sources including texts, illustrations, references, and human experts. In addition to informational texts, literature including stories, folklore, novels, and poetry were woven through the instruction.

Most of the teachers began the units with a narrative related to the theme that students read at the same time they were conducting science observations. Following observing and forming conceptual questions, teachers moved to informational texts. As students concluded their in-depth study of multiple informational texts, teachers introduced novels, chapter books, and poetry related to the conceptual theme of the unit.

The last phase of the CORI framework is communicating to others. Having gained expertise in a particular topic, students were motivated to speak, write, discuss, and display their understanding to other students and adults. In both third- and fifth-grade classrooms, students made posters, wrote classroom books, and composed extended displays of their knowledge. One class made a videotape of its weather unit, providing a lesson on weather prediction and explanation for the rest of the school. A more thorough description of the CORI instructional framework is provided elsewhere (Guthrie, McGough, Bennett, & Rice, 1996).

The teachers in the traditional classrooms followed their usual pattern of using the teachers' guide and the sequence of content and activities in the basal program. Students answered the end of unit questions, and were provided materials that matched their reading levels. Science content in the third- and fifth-grade basal-reading classrooms was directed to similar objectives as the CORI classrooms. Topics of adaptation, life cycles, weather and seasons, and solar systems were taught. The basal teachers in all of the schools were frequent visitors to the CORI classrooms and adopted some texts and teaching approaches used in the CORI classrooms. This sharing may have lead to an underestimate of the distinctiveness of the CORI program, and to a conservative quasi-experimental comparison.

Performance Assessment of Reading/Language Arts

The performance assessment was designed to measure seven aspects of literacy engagement. More information is available in Guthrie et al. (1996). The assessment was administered during a 1-week period in each basal and CORI classroom by the teachers. All students took the assessment in the same 3-week period at the beginning of April 1995. Students worked approximately 1 hr daily for 5 days. The assessment consisted of a learning context with seven tasks. The tasks will be described here, and rubrics for coding performance are presented in the Appendix. The assessment was introduced with an observational activity. Students were given a colored picture of a pond with fish, insects, birds, and trees. With a partner, students discussed all the things they observed in the picture for 5 min.

Prior knowledge. After viewing the picture, students worked independently to write their knowledge of the topic before entering the search phase. Students were asked to "explain how ponds are different from deserts" and were aided in the task by being asked, "What is a pond like? What is a desert like? How are they different?" All students were given sufficient time to finish their writing.

Search. Students were next given an opportunity to search for ideas and information about ponds and deserts. Their task was to "explain the differences between ponds and deserts." Students were given a 46-page booklet containing 14 sections with 1–5 pages of information. A table of contents, index, and glossary were provided. Four of the sections were not directly relevant to the question and 10 were directly useful. Of the 10 relevant sections, 5 were appropriate for third-grade students, and 5 were more likely to be appropriate for fifth-grade students.

Students were given a log to fill out during the search activity. In the log, they were asked to present which section they selected, their reasons for choosing this information, and their notes on what they learned from the section. Students were given an unlimited amount of space to fill out their log. The search took place during a 1-hour period on 2 different days, allowing students as much time as they thought they needed to complete the activity. Students who finished early were permitted to rest or read a book of their choice.

Drawing. Students were first asked to "Draw a picture to show how ponds are different from deserts." Students were asked to label the important parts and given ample time for the activity.

Writing. After completing the drawing, students were given a writing task with the following instructions, "Write an explanation of how ponds are different from deserts." Asked to write about the important parts of ponds and deserts and use science ideas in their explanations, students were given unlimited time for this activity. Following the writing task, students were given six specific questions to probe their knowledge of these biomes more deeply. The questions addressed particular animals, their habitats, and their adaptations to the habitat.

Conceptual transfer. Students were asked to perform a task that required them to transfer their knowledge from the previous learning activities. The instructions were as follows, "Suppose some people drink all of the water from a pond one day, would the pond now be like a desert? Please explain your answer." Students were not permitted to refer to their previous drawings, writings, or texts. They were given ample time to complete the activity and encouraged to think extensively as they performed the activity.

Informational text comprehension. Students were given an expository text containing prose, a diagram, and an illustration. They were given instructions to read this material and answer four questions. The first question required the students to integrate information across all three forms of information in the task. The next three questions asked students to address the illustration, the text, and the diagram in that order. Space was given for each answer separately.

Narrative interpretation. In this stage, students were provided a narrative of approximately 1,000 words. An age-appropriate, authentic short story was given for each grade level. Students answered three questions, the first addressing recall of a particular event, the second addressing the author(s) perspective on one character, and the third addressing the theme of the literary selection.

Performance Assessment Coding Rubrics

Coding rubrics were constructed to classify the students' responses on each task of the performance assessment. To build the rubrics, we started with the writing task. We sorted the responses of 25 students holistically into six relatively higher and lower categories. We then identified the critical qualities of each level. An independent graduate student rated 25 responses according to these categories to examine the interrater agreement. Having established a rubric for the writing task, the rubric was used for prior knowledge, drawing, and transfer. The search rubric was constructed in a similar manner. Twenty-five responses were sorted into six categories to measure reliability. The interrater agreements for adjacent and exact coding into these categories, respectively, were: prior knowledge (96%, 84%), search (92%, 84%), drawing (96%, 88%), writing (96%, 80%), conceptual transfer (92%, 80%), informational text comprehension (100%, 85%), and narrative interpretation (95%, 90%—third grade; 100%, 85%—fifth grade).

Motivational and Strategy Questionnaire

Following the search activity, students were given a 35-item questionnaire about their motivations and strategies for performing the search activity. One set of questions addressed intrinsic motivations for the task (e.g., "After reading one packet about ponds and deserts, I wanted to read more"). The second set of questions elicited the students' use of strategies (e.g., "After I took some notes, I went back to the packet to make sure I didn't miss anything"). The response mode was: (1) not like me at all, (2) a little like me, (3) sort of like me, (4) a lot like me. Students were instructed that they should think about how they felt while they were searching and answer accordingly.

Teacher Observational Rating

To construct a measure of students' general level of literacy and science background at the beginning of the year, teachers conducted observational ratings. For each child in the basal and CORI classrooms, the teacher rated each child according to her quintiles in literacy and science, using the grade-level students in the school as the reference group. These ratings were used as a covariate in some of these statistical analyses to adjust the traditional and CORI classrooms.

Instructional Questionnaire and Intervention Check

To determine the extent to which the principles of CORI were being implemented, we developed an instructional questionnaire. Based on analyses of videotaped sessions of the CORI and focal groups with teachers in the previous year, we identified seven dimensions of the CORI learning context including: (a) observational experiences related to science phenomena, (b) an orientation towards conceptual knowledge, (c) student-direction, (d) a collaborative atmosphere among the learners, (e) explicit teaching of cognitive strategies to improve reading and writing, (f) opportunities for different modes of personal expression of knowledge, and (g) the integration of science topics with language arts processes.

The research team wrote 99 items which addressed each of the seven dimensions. The response format was a likert scale ranging from 1 to 4. Sometimes the response choices were worded as "very true of my class" to "not at

Table 1
Teacher Questionnaire on CORI and Traditional Teaching

Instructional Dimension	No. of Items	Reliability	Correlation with Instructional Program
Real-World Experience (Observational vs. Abstract)	9	.90	.97
Knowledge (Conceptual vs. Factual)	12	.89	.97
Direction of Control (Student vs. Teacher)	15	.91	.95
Social (Collaborative vs. Individual)	13	.66	.86
Strategies Taught (Explicitly vs. Implicitly)	9	.75	.61
Written Expression (Personal vs. Conventional)	9	.47	.20
Integration of Language Arts & Science (Integrated vs. Departmentalized)	8	.71	.90

*$p < .001$

all true of my class." Other items asked the teachers to estimate the time invested in an instructional practice with choices ranging from "almost every day" to "once a month or less." A trial version of the questionnaire was given to the 5 CORI and 5 comparison teachers for review. They were asked to identify items that they felt reflected their own teaching practices most effectively. The participants were also invited to give written feedback about items on the questionnaire. As a result of the teachers' comments, some items were changed, reordered, or reverse-coded. The resultant questionnaire was administered to the participants in the spring of the academic year. Fourteen items were excluded from analyses because of missing data. Six additional items were withheld because they showed low variability.

This instructional questionnaire contained seven bipolar scales. For example, the scale on direction of instructional control ranged from student-directed (more CORI-like) or teacher/program-directed (more traditional). Items in this scale were coded to reflect either an emphasis on student direction or an emphasis on teacher direction. Questionnaire data are displayed in Table 1. Reliabilities are generally adequate, except written expression. Correlations with instructional type were all significant, except written expression. A positive correlation indicated that CORI teachers emphasized the left side of the bipolar dimension; whereas traditional teachers emphasized the right side of the dimension. The CORI versus traditional emphasis is shown parenthetically in Table 1.

Procedures

Students in the CORI classrooms received a full academic year of this teaching, and the control students received traditional instruction throughout the year. Teachers had full responsibility for all instruction, and participated in an inquiry workshop monthly, led by the University researcher, to share progress and problems. The performance assessment was given by the teachers in the first half of April. Traditional students performed comfortably on the performance assessment, finding it to be an enjoyable activity. Coding of the performance assessment was completed by the graduate students and the first author.

Results

The data were analyzed to explore the model in Figure 1 and to address each question at the end of the introduction. Measures from the performance assessment and teachers' ratings were used as indicators of the constructs in Figure 1. Conceptual learning was measured with the combined writing and drawing score because students often referred to their drawings in their written work. The indicator of literacy engagement was the score on the search task, which consisted of extended reading and notetaking from multiple, illustrated texts. On the search task, strategies of searching, comprehending, integrating, and summarizing were needed. Motivational dispositions of interest, effort, persistence, and self-efficacy were expected to be beneficial in this task as suggested in previous studies (Guthrie, et al., 1996).

To measure conceptual learning with maximally sensitive procedures, we asked students follow-up questions after their writing and drawing activity. We constructed a prompted score by placing students on the writing rubric after accounting for the follow-up questions. Analysis of the prompted scores showed that students attained significantly higher rubric levels on prompted than on writing-only tasks, $t(221) = 7.94, p < .0001$. To examine whether the advantage varied by grade or instructional program, we conducted a 2 (grades) X 2 (types of instruction) analysis of variance (ANOVA) on the difference of writing and prompted scores. No significant effects were observed. Therefore, we used the writing scores in subsequent analyses.

Students' literacy levels and general science knowledge in the fall of 1994 were rated by the teachers and reading specialists. These two ratings were combined to obtain a general literacy-science background measure. Prior knowledge on the topic of the assessment was drawn from the prior knowledge task in the performance assessment.

Question 1

Does literacy engagement increase conceptual learning when science background, literacy level, and topic knowledge are controlled? This question addresses the strength of link A in Figure 1. We used the data for both grades and both instructional programs. To analyze the data, a hierarchial multiple regression was conducted in which the dependent variable was the combined score of writing and drawing representing conceptual learning. Independent variables were entered in the order of a combined background score of literacy level and science knowledge, prior knowledge of the topic in the performance assessment task, and the search score, which was the indicator of literacy engagement.

Multiple regression analysis showed that search (literacy engagement) significantly predicted writing and drawing (conceptual learning) when the background variables were taken into account. The multiple regression was $R = .62$, ($p < .0001$); search (literacy engagement) accounted for 10% of the unique variance in writing and drawing (conceptual learning), which was significant at $p < .0001$, as indicated in Table 2.

We also addressed Question 1 for the grade-5 and grade-3 students separately. A hierarchial multiple regression for combined writing and drawing as the dependent variable, with literacy and science background, prior knowledge, search, and instruction as independent variables. In grade 5, search contributed 18% of the unique variance ($p < .0002$) in writing and drawing and had a multiple regresion of .63. For grade 3, the multiple regression was .60, and search contributed 4% of the unique variance ($p < .05$) in writing and drawing. Referring to Figure 1, these data showed that link A was significant, when links 1 and 2 were controlled. The relationship held for grade 5 and grade 3 separately, as well as for the total group.

Question 2

Does CORI increase literacy engagement when background factors are controlled? This question refers to link B of Figure 1. Having shown that our indicator of literacy engagement (search) predicted conceptual learning (writing and drawing), we attempted to determine whether CORI increased literacy engagement. To examine this question, we conducted a hierarchial multiple regression analysis in which the total search score was the dependent variable and the independent variables were the combined background literacy-science score, the prior knowledge score, and the integrated instruction score. Instruction was entered as a contrast between the CORI and the traditional programs. A multiple regression of .50 was observed. Instruction accounted for 17% of the variance in search after background factors were controlled, which was highly significant ($p < .0001$). As Table 3 shows, these findings were also observed for grades 5 and 3 separately. For grade 5, instruction accounted for 20% of the unique variance ($p < .0002$); and for grade 3, instruction accounted for 17% of the unique variance ($p < .0002$). These findings show that CORI enhanced literacy engagement, as indicated by search, in both grade 5 and grade 3. Referring to Figure 1, link B was confirmed to be important by this analysis.

Table 2
Multiple Regression Analyses for Questions 1 & 3

Group	Dependent	Independent	*R*	R^2	R^2Cha	SigCha
Total Group	Write & Draw	Literacy/Science	.35	.12	.12	.0001
		Prior Knowledge	.53	.28	.15	.0001
		Search	.62	.38	.10	.0001
		Instruction	.67	.45	.07	.0003
Grade 5	Write & Draw	Literacy/Science	.27	.07	.07	.04
		Prior Knowledge	.47	.22	.14	.002
		Search	.63	.40	.18	.0002
		Instruction	.72	.52	.12	.0007
Grade 3	Write & Draw	Literacy/Science	.39	.15	.15	.001
		Prior Knowledge	.56	.32	.16	.0003
		Search	.60	.36	.04	.05
		Instruction	.64	.41	.05	.03
Total Group	Write & Draw	Literacy/Science	.34	.12	.12	.0001
		Prior Knowledge	.52	.27	.15	.0001
		Search Total	.60	.36	.09	.0001
Total I	Write & Draw	Literacy/Science	.34	.12	.12	.0001
		Prior Knowledge	.52	.27	.15	.0001
		Search—Packets	.60	.36	.09	.0001
Total I	Write & Draw	Literacy/Science	.34	.12	.12	.0001
		Prior Knowledge	.52	.27	.15	.0001
		Search—Reasons	.56	.31	.04	.007
Total I	Write & Draw	Literacy/Science	.34	.12	.12	.0001
		Prior Knowledge	.52	.27	.15	.0001
		Search—Notes	.60	.36	.09	.0001

Question 3

Does CORI increase conceptual learning when literacy engagement and background factors are controlled? The previous analyses have suggested that literacy engagement (indi cated by the score on search) increased conceptual learning (indicated by combined writing and drawing) and that integrated instruction (CORI) increased literacy engagement in com

Table 3
Multiple Regression Analyses for Question 2

Group	Dependent	Independent	*R*	R^2	R^2Cha	SigCha
Total Group	Search Total	Literacy/Science	.26	.07	.07	.0003
		Prior Knowledge	.29	.09	.02	.11
		Instruction	.50	.25	.17	.0001
Grade 5	Search Total	Literacy/Science	.22	.05	.05	.08
		Prior Knowledge	.24	.06	.01	.49
		Instruction	.50	.25	.20	.0002
Grade 3	Search Total	Literacy/Science	.27	.07	.07	.03
		Prior Knowledge	.34	.12	.04	.08
		Instruction	.53	.29	.17	.0002

parison to traditional teaching. We next asked whether instruction enhanced conceptual learning beyond its influence on literacy engagement. To examine this question, we conducted a hierarchial multiple regression analysis with the dependent variable of combined writing and drawing. The independent variables were literacy and science background, prior knowledge of the topic, search, and instruction. To perform this analysis, we added instruction as a final independent variable to the regression analysis conducted for question 1. The results are shown in Table 2.

The findings for instruction as the independent variable were that a multiple regression of .67 was obtained for the total group. Instruction contributed 7% of the unique variance in conceptual learning, which was significant ($p < .0003$). When the same hierarchial multiple regression was conducted for grade 5, a multiple regression of .72 was obtained, and instruction accounted for 12% of the unique variance ($p < .0007$). For grade 3, the same regression analysis produced a multiple regression of .64, with instruction accounting for 5% of the unique variance that was significant ($p < .03$). With reference to Figure 1, these results confirm the importance of link C. The results can be interpreted as showing that CORI increased conceptual learning, in comparison to traditional instruction. The findings suggest that CORI had a direct effect on conceptual learning (link "C") as well as indirect effect through literacy engagement (links B and A).

Question 4

How do students in grades 3 and 5, who receive CORI, compare to other students in level of literacy engagement? This question was addressed with a 2 (grade levels) X 2 (instructional types) analysis of covariance (ANCOVA). Covariates were literacy and science background and prior knowledge, and the dependent variable was literacy engagement as indicated by the search score. A significant effect occurred for instructional type with CORI students higher than students in traditional instruction. A significant effect occurred for the grade, and the interaction effect was not significant. The findings are plotted in Figure 2.

The ANCOVA showed that CORI was higher than traditional instruction in literacy engagement at grade 3 and grade 5. To compare the four individual means of the two instructional groups at the two grade levels, we conducted post hoc contrasts. The procedure consisted of coding the four groups into four levels of one dummy variable. One-way ANCOVA with Newman-Keuls contrasts were conducted on this variable. The result was that CORI grade-5 was significantly higher than all other groups including traditional grade 5 ($p < .05$). Next, CORI grade-3 was higher than traditional grade 3 ($p < .05$). In addition, CORI grade-3 was significantly higher than traditional grade 5 ($p < .05$). Finally, traditional grade 5 was not significantly higher than traditional grade 3. It seems noteworthy that CORI grade-3 exceeded traditional grade 5 in this search-based measure of literacy engagement, and that students in grade 3 and grade 5 traditional instruction were not different.

Question 5

How do students in grades 3 and 5 who receive CORI compare to traditional students in conceptual learning? This question was addressed with a 2 (grade levels) X 2 (instructional types) ANCOVA. Covariates were literacy and science background and prior knowledge, and the dependent variable was conceptual learning as indicated by the combined writing and drawing. A significant effect occurred for instructional type, $F(1,119) = 32.61$, $p < .0001$, showing that CORI students were higher than traditional instruction students. A significant effect was found for grade, $F(1,119) = 5.39$, $p < .02$. The interaction of instruction and grade was not significant. The findings are plotted in Figure 3.

To examine the means of the two instructional groups at two grade levels, a one-way ANOVA on the four groups was conducted with Newman-Keuls post hoc contrasts. These comparisons showed that CORI grade-5 was significantly ($p < .05$) higher than all of the other groups, CORI grade-3 was significantly higher than traditional instruction grade 3 ($p < .05$). In this analysis, CORI grade-3 was not significantly different from traditional grade 5, and the two traditional groups at grade 3 and grade 5 were not significantly different from each other.

As Figure 3 shows, CORI grade-3 was higher than traditional grade 3. This difference was statistically significant using the Bonferroni-t statistic, assuming two comparisons ($p < .025$). Although the Newman-Keuls contrast did not show a significant difference, for this comparison, due to the exploratory nature of this study, we believe results of the Bonferroni-t statistic should be considered seriously.

Question 6

How does conceptual transfer relate to conceptual learning, literacy engagement, and integrated instruction in grades 3 and 5, when background factors are controlled? We ad-

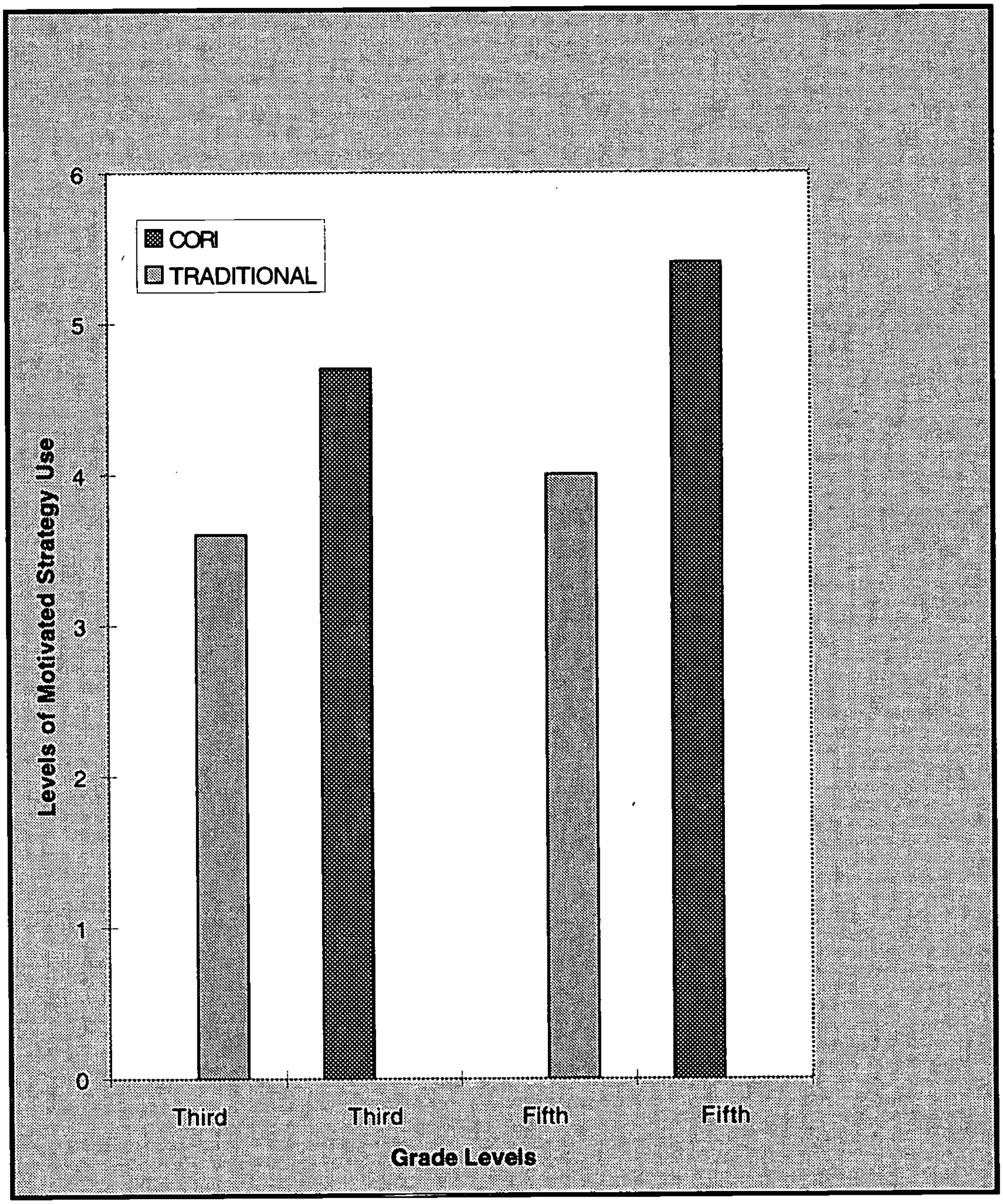

Figure 2. Motivated strategy use of CORI and traditional students at third- and fifth-grade.

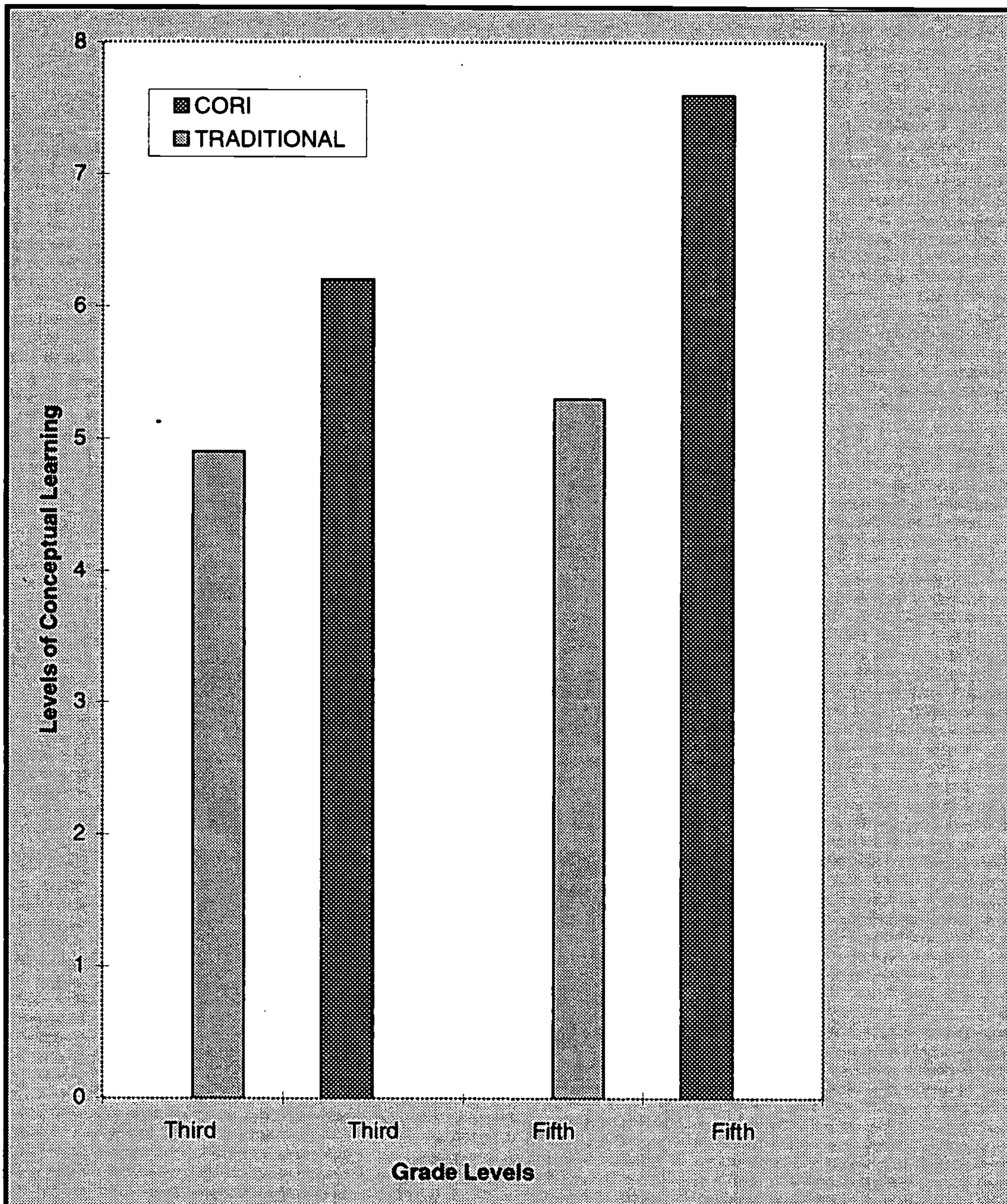

Figure 3. Conceptual learning at levels of CORI and traditional students at third- and fifth-grade.

Table 4
Multiple Regression Analyses for Transfer in the Total Group (Question 6)

Group	Dependent	Independent	*R*	R^2	R^2Cha	SigCha
Total I	Transfer	Literacy/Science	.31	.09	.09	.001
		Prior Knowledge	.38	.15	.05	.01
		Search	.45	.20	.05	.01
		Instruction	.45	.20	.00	ns
Grade 5	Transfer	Literacy/Science	.14	.02	.02	ns
		Prior Knowledge	.28	.08	.06	.06
		Search	.50	.25	.17	.0008
		Instruction	.60	.35	.10	.005
Grade 3	Transfer	Literacy/Science	.45	.20	.20	.001
		Prior Knowledge	.51	.26	.06	.06
		Search	.52	.27	.01	ns
		Instruction	.54	.29	.02	ns
Total I	Transfer	Literacy/Science	.32	.10	.10	.001
		Prior Knowledge	.39	.15	.05	.01
		Write & Draw	.53	.28	.13	.0001
		Instruction	.53	.28	.00	ns
Grade 5	Transfer	Literacy/Science	.12	.01	.01	ns
		Prior Knoweldge	.24	.06	.05	ns
		Write & Draw	.65	.42	.36	.0001
		Instruction	.68	.46	.04	.05
Grade 3	Transfer	Literacy/Science	.46	.21	.21	.0009
		Prior Knowledge	.52	.28	.07	.05
		Write & Draw	.53	.28	.00	ns
		Instruction	.59	.35	.07	.03

dressed this question with six multiple regressions using conceptual transfer as the dependent variable. In the first analysis, the independent variables were the literacy and science background, prior knowledge, search, and integrated instruction. As Table 4 shows, search accounted for 5% of the unique variance ($p < .01$) in conceptual transfer. Instruction did not contribute significantly to conceptual transfer after search and background factors were controlled.

This part of question 6 was examined separately for grades 3 and 5. The multiple regression for grade 5 using conceptual transfer as the dependent variable with literacy and science background, prior knowledge, search, and instruction as independent variables produced a multiple regression of .60. The search variable accounted for 17% of the unique variance ($p < .0008$) and instruction accounted for 10% of the unique variance ($p < .005$). In grade 3, however, search and instruction did not contribute significantly to transfer, using the same multiple regression procedure used for grade 5 (see Table 4).

To address Question 6 further, a hierarchial multiple regression was conducted with conceptual transfer as the dependent variable, using literacy and science background, prior knowledge, writing and drawing, and instruction as the independent variables. For the total group, writing and drawing contributed 13% of the unique variance in conceptual transfer, which was significant ($p < .0001$), but instruction did not add significantly. When this hierarchial multiple regression was conducted for grade 5 and grade 3 separately, a different picture appeared. For grade 5, writing and drawing contributed 36% of the unique variance in conceptual transfer, which was significant ($p < .0001$); and instruction added 4% of the unique variance in conceptual transfer ($p < .05$). For grade 3, writing and drawing did not contribute a significant amount of unique variance to conceptual transfer. However, for grade 3, instruction added 7% of the unique variance in transfer ($p < .03$) after the factors of conceptual learning and student background were taken into account (see Table 4).

These results of the multiple regression analyses on conceptual transfer are depicted in Figure 4. For the total group, links D and E were significant when controlling for links 1 and 2. For grade 5, links D and E were significant when controlling for 1 and 2. In addition, link F (CORI) was significant when controlling for 1 and 2, and separately for D and E. For grade 3, path E (CORI) was significant when controlling for links 1, 2, and D.

Question 7

What effect does CORI have on comprehension of informational and narrative text? Reading comprehension of informational and narrative texts were measured with different texts at grade-appropriate levels for third- and fifth-graders. To examine the effects of CORI on comprehension, separate analyses were conducted using a one-way ANCOVA with literacy level as the covariate. For grade 5 with informational text, the CORI group was not significantly higher than the traditional instruction group. For grade 5 with narrative text, the CORI group was significantly higher than the traditional instruction group, $F(1, 64) = 15.31$, $p < .0001$. For grade 3 with informational text, the CORI group was not significantly different from the traditional group. For grade 3 with the narrative text, the traditional group was higher than the CORI group, $F(1,118) = 5.26$, $p < .02$ (see Table 5).

Question 8

What instructional principles distinguish CORI and traditional instruction? This question was addressed in the Method section. The dimensions (Scales) on the instructional questionnaire were correlated with the dichotomous

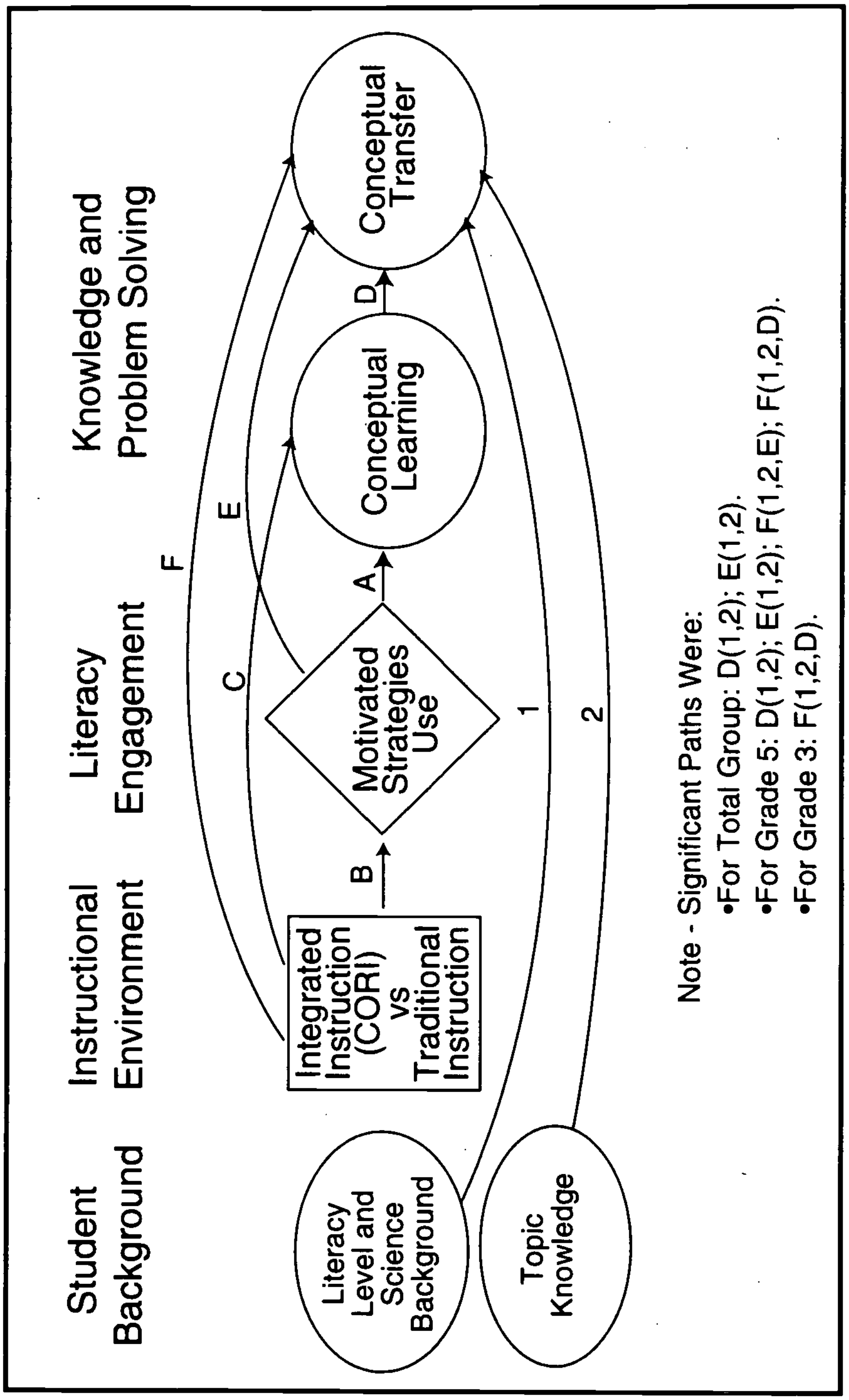

Figure 4. Promoting conceptual transfer through literacy engagement and integrated instruction.

Table 5
Results on the Performance Assessment

Variable	Condition	*N*	Mean	*SD*
Third Graders				
Literature Covariate	CORI	39	2.87	1.20
	Basal	39	3.23	1.49
Science Covariate	CORI	39	2.90	1.55
	Basal	39	3.28	1.32
Prior Knowledge	CORI	42	2.57	1.06
	Basal	36	2.03	.77
Writing	CORI	44	3.23	1.22
	Basal	38	2.39	1.26
Drawing	CORI	44	2.95	1.38
	Basal	38	2.53	1.16
Writing and Drawing	CORI	44	6.18	2.19
	Basal	38	4.92	2.05
Search Relevant Packet	CORI	48	5.46	1.50
	Basal	42	3.93	1.85
Search Notes	CORI	48	4.75	1.00
	Basal	42	3.88	1.27
Search Reason	CORI	48	4.71	.92
	Basal	42	4.10	1.27
Search Total	CORI	48	4.69	.99
	Basal	42	3.64	1.39
Informational Text	CORI	45	7.42	1.54
	Basal	42	7.02	1.87
Story Comprehension	CORI	46	6.00	1.62
	Basal	39	6.46	1.41

Table 5 (continued)
Results on the Performance Assessment

Variable	Condition	*N*	Mean	*SD*
Fifth Graders				
Literature Covariate	CORI	36	3.31	1.49
	Basal	37	3.35	.89
Science Covariate	CORI	36	3.75	1.27
	Basal	37	3.30	1.18
Prior Knowledge	CORI	36	2.53	.84
	Basal	42	2.12	.77
Writing	CORI	35	4.03	1.34
	Basal	40	2.80	1.02
Drawing	CORI	35	3.54	1.17
	Basal	40	2.53	.99
Writing and Drawing	CORI	35	7.57	2.08
	Basal	40	5.32	1.72
Search Relevant Packet	CORI	40	5.48	1.52
	Basal	42	4.31	1.44
Search Notes	CORI	40	5.60	1.01
	Basal	42	4.24	1.27
Search Reason	CORI	40	4.65	1.10
	Basal	42	4.38	.94
Search Total	CORI	40	5.40	1.10
	Basal	42	4.00	1.29
Informational Text	CORI	41	8.71	1.47
	Basal	37	8.65	1.51
Story Comprehension	CORI	40	5.90	1.61
	Basal	39	4.67	1.44

variables of instructional type. As Table 1 shows, correlations were: real-world experience (.97), knowledge (.97), direction of control (.95), social (.86), strategies taught (.61), written expression (.20), and integration of language arts and science (.90). This confirmed the distinctions between CORI and traditional instruction on six of the seven dimensions.

STUDY II
Introduction

Purpose

The purpose of Study II was to compare the effects of CORI with traditional instruction on a statewide assessment. The assessment is part of the Maryland School Performance Assessment Program (MSPAP) which is linked to a systemic reform effort in education. The MSPAP contains measures of achievement in reading, writing, language use, science, math, and social studies. The goal of this investigation was to compare CORI and traditional instruction in each of these measures for students at grades 3 and 5 in one elementary school.

Rationale

The MSPAP is a statewide design for educational reform. The design includes: identification of learning outcomes, development of performance standards, administration of performance assessments, implementation of instructional improvements, and publication of assessment results. Standards in reading, writing, and science were constructed for all students. The objectives of the MSPAP and the CORI were highly similar. For example, standards in reading for both MSPAP and CORI included: summarize a story, play, or poem; identify a theme of a novel; infer traits and motives of characters; restate information from an expository text; identify the organizational structure of a selection; evaluate the effectiveness of an author's argument; draw inferences from information in illustrations and text; identify similarities of tables and graphs; and compare different forms of documents.

In view of the agreement in objectives between the MSPAP and CORI, it is reasonable that students receiving concept-oriented reading instruction should show relatively high achievement in the aspects of MSPAP taught within CORI. As the CORI objectives are related to reading, writing, and science, it was reasonable to expect that these tests should reflect the effectiveness of CORI. On the other hand, CORI did not include instruction in math or social studies and therefore, it was not expected that these two areas would be influenced by participation in CORI. We expected that language use would be influenced favorably by CORI because expectations for writing in CORI were substantial.

Although the global objectives of MSPAP and CORI are similar, there are several reasons to doubt whether the Maryland Performance Assessment would show an effect of an instructional intervention such as CORI. First, the particular reading competencies in the assessment were not specifically tied to the particular competencies in CORI. For example, although both teach higher-order reading strategies, CORI emphasizes search for information from multiple texts, whereas the Maryland assessment emphasizes summary of informational text. Separate scores in the Maryland assessment are not obtained for such specific competencies as searching and summarizing. In the absence of this specificity, it is possible that the measure is not sensitive to an intervention that targets a few particular higher-order strategies. Second, the content of science in the Maryland assessment was not related to the content of science instruction in CORI. In CORI, life sciences were emphasized with some attention to earth science and physical science. However, in the Maryland assessment physical science, earth science, and life science were equally emphasized. Therefore, it is the science processes of hypothesizing, data collecting, predicting, inferring, and drawing conclusions taught in CORI that may be observed in Maryland assessment rather than gains in content knowledge.

Third, student effort for participating in the Maryland assessment is not remarkably high. Many students fail to see the purpose of these activities and do not invest optimal effort in them. Fourth, the Maryland assessment requires substantial levels of self-assessment. Students are expected to appraise their own strategies for learning, comment on alternative methods of performing tasks and reflect on their reactions to text. The self-assessments were not emphasized in CORI as fully as they were in the Maryland assessment. These differences between MSPAP and CORI lead to realistic doubts about whether the Maryland assessment will be sensitive to benefits of CORI in the form documented in Study I of this investigation. Fifth, approximately 40% of the students who received the Maryland assessment in April 1994 were not present in the school for the full 1993-94 academic year. Consequently, it is unlikely that the CORI program could have influenced their learning substantially.

Method

Students

In one elementary school, CORI was implemented in one grade-5 and one grade-3 classroom in the 1993–94 year. Students in these classrooms were assigned to the CORI project because it was believed that they would benefit from special attention to their reading and writing development. Both classes included approximately 4–6 learning disabled students who were maintained in the self-contained classroom for reading, writing, and science instruction. There were 31 grade-3 and 27 grade-5 students for whom data were available. There were 48 grade-3 and 45 grade-5 students from traditional instruction classrooms for whom data were available. Students were heterogeneously grouped in classes and included approximately 65% African-American, 20% Hispanic, 10% Caucasian, and 5% Asian. These proportions were roughly representative of the district.

Teachers and Program

One grade-3 and one grade-5 teacher taught CORI in a yearlong integration of science, reading, and writing instruction. This was the first year of implementation for grade 3 and the second year for grade 5. Teachers were supported by a small team of one faculty member and one student at the University of Maryland. The school was a Chapter One, K–6 school with a high proportion of students reading and writing in the lowest quartile.

The instructional framework was the same as the framework described in Study I. Instructions of the 16-week units contain four phases consisting of: (a) observe and personalize; (b) search and retrieve; (c) comprehend and integrate; and (d) communicate to others. In each of these phases, teachers supported students in generating their learning goals; gaining strategies to understand the text; reading multiple genre including informational texts, narratives, folktales, and poetry; and writing extensively to communicate their new learning to peers. Student portfolios were emphasized as a means to exhibit class work for students, teachers, parents, and administrators.

Performance Assessment

The MSPAP was administered in April 1994 by the teachers according to the guidelines. The students were placed in a room different from their homeroom and were given directions to perform a timed series of tasks in science, social studies, and math during 1 week. Scores for reading, writing, and language use were derived from the students work on content-based tasks. For example, students may have performed a hands-on science activity collecting and interpreting data. Immediately following, they read an informational text related to the science concepts inherent in the activity and summarized the connections between the text and activity. The quality of the summary of text was used as a portion of the reading score. The qualities of the writing and language use in the summary were used to contribute to the scores on those scales, respectively.

Results

To compare achievement of students receiving CORI to students receiving traditional instruction, analyses were conducted on each measure on the Maryland assessment separately. The means are shown in Table 6 and Figure 5. A 2 (types of instruction) X 2 (grades) ANOVA was performed on reading, writing, literacy #1 (sum of reading and writing), language use, literacy #2 (sum of reading, writing, and language use), science, social studies, and math. Each two-way ANOVA was followed by a one-way ANOVA on program effects at grade 3 and grade 5 separately (see Table 6).

The analysis of literacy #1 showed a significant advantage of CORI compared to traditional instruction, $F(1, 145) = 4.31, p < .04$. The grade-level and interaction effects were not significant. The ANOVA for reading and the ANOVA for writing did not show any significant effects of the type of instruction or any interaction effects. The ANOVA on the language use measure showed a significant benefit of CORI compared with traditional instruction, $F(1, 142) = 3.86$, $p < .05$. There was a significant grade effect, $F(1, 142) = 8.46$, $p < .0004$, but no significant interaction. The ANOVA for literacy #2, which combined reading, writing, and language use, showed a significant benefit for CORI compared with

Table 6
Means and Standard Deviations for CORI and Traditional Students on the Maryland School Performance Assessment

Variable & Program		Students' Grade					
		Third		Fifth		Third & Fifth	
		M	*SD*	*M*	*SD*	*M*	*SD*
RD	CORI	503.70	42.22	517.43	50.82	510.33	46.67
	Trad	486.71	58.72	504.19	45.75	495.18	53.29
WR	CORI	508.30	43.42	504.15	51.71	506.43	46.96
	Trad	491.27	41.98	494.91	45.34	492.98	43.40
LU	CORI	507.72	43.86	519.81	38.53	513.55	41.45
	Trad	484.09	40.68	512.89	57.03	498.17	51.17
MS	CORI	518.69	28.93	510.96	25.64	514.96	28.93
	Trad	499.41	45.55	512.34	45.80	499.41	45.55
SS	CORI	508.31	35.06	511.39	32.70	509.82	33.65
	Trad	490.34	43.60	502.24	45.00	495.98	44.44
SC	CORI	515.29	25.42	521.81	30.60	518.33	27.89
	Trad	492.71	43.26	511.04	45.58	501.58	45.11
Lit1	CORI	1014.83	65.40	1024.15	82.40	1019.32	73.55
	Trad	984.62	83.03	999.63	77.83	999.04	80.42
Lit2	CORI	1522.55	95.90	1543.96	106.80	1532.88	100.95
	Trad	1465.85	111.51	1514.11	127.37	1489.44	121.30

Note. RD = Reading; WR = Writing; LU = Language Use; MS = Mathematics; SS = Social Studies; SC = Science; Lit1 = Literacy (RD=WR); Lit2 = RD+WR+LU.

traditional instruction, $F(1, 142) = 5.17, p < .02$. On literacy #2, a significant effect for grade appeared, $F(1, 142) = 4.12, p < .04$, but the interaction was not significant.

On the science scores, the ANOVA showed a significant advantage for CORI compared with traditional instruction, $F(1, 147) = 6.80$, $p < .01$. A significant grade effect appeared, $F(1, 147) = 4.73, p < .03$, but the interaction of instruction and grade was not significant. A significant advantage for CORI also appeared on the social studies measure, $F(1, 148) = 4.03$,

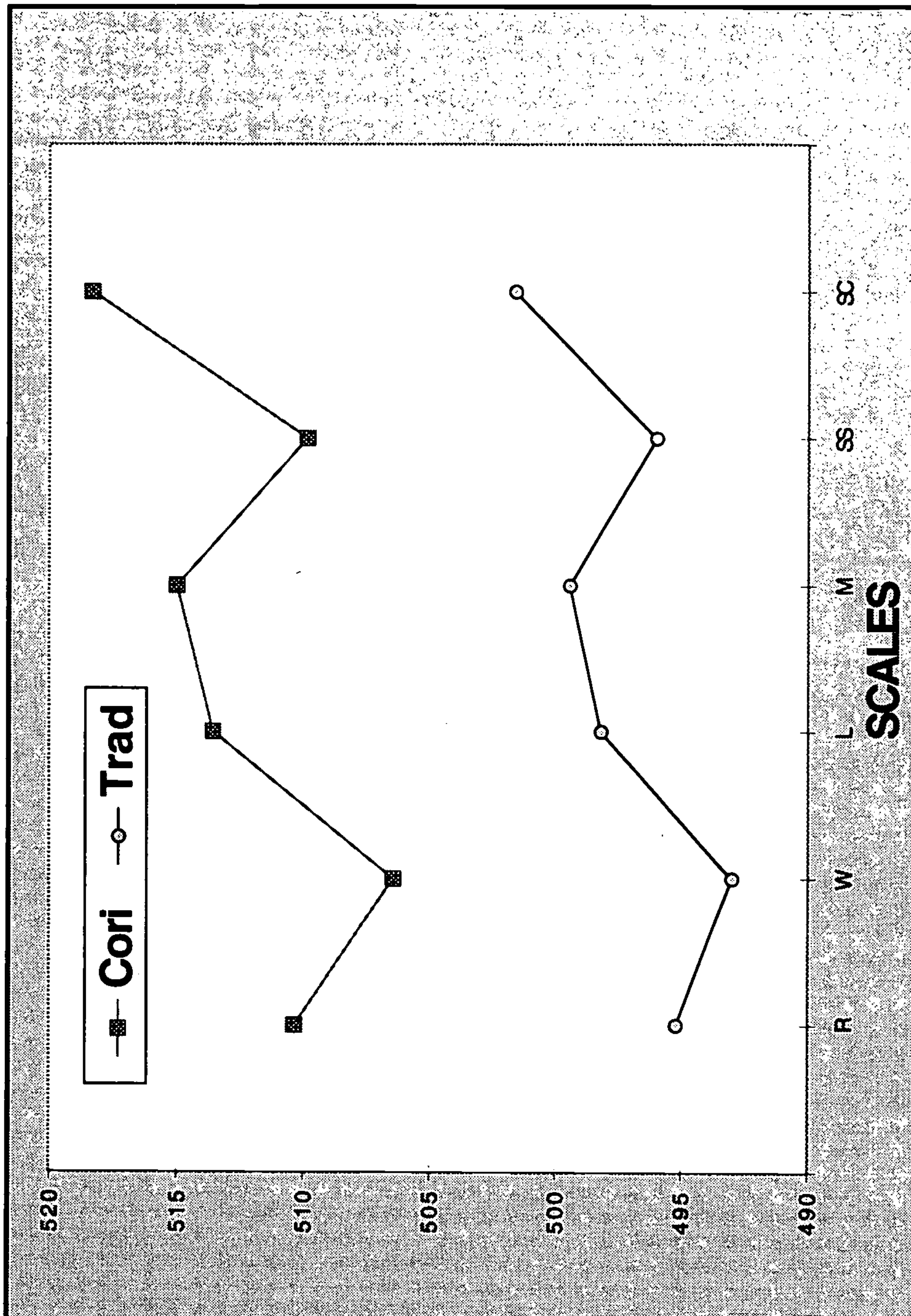

Figure 5. Comparison of CORI and traditional students on reading, writing, language use, math, social studies, and science in the Maryland Performance Assessment.

Table 7
Comparison of CORI and Traditional Instruction on the Maryland Performance Assessment

Measures	Total (Grades 3 & 5)
Reading	ns
Writing	ns
Literacy #1 (R+W)	*
Language Use	*
Literacy #2 (R+W+LU)	*
Science	*
Social Studies	*
Math	ns

Note. ns = Not significant; * = Significant instructional effect at $p < .05$.

$p < .05$, but there were no grade or interaction effects. On the math measure, there were no significant effects for instruction, or grade, on the interaction of instruction and grade.

The interaction of instruction and grade was not statistically significant in any of the analyses, which signifies that the advantage for CORI in achievement was not significantly different for grade 3 and grade 5. Therefore, separate grade-specific analyses are not warranted according to strict criteria.

These comparisons of CORI with traditional instruction were consistent with our expectations (see Table 7). Students who received CORI were higher in literacy than students receiving traditional instruction. The literacy measure was a combination of the reading and writing scores from the Maryland assessment. Combining them is consistent with the philosophy of CORI and with the goals of the systemic change that include the integration of reading and writing for authentic school learning purposes.

Students receiving CORI showed higher achievement in science than students receiving traditional instruction, this was expected because CORI is an integration of language arts and science for elementary school learners. In addition to science, CORI students were higher than traditional students in language use. This was a measure of the skills and craft of writing, including sentence structure, capitalization, and word use. The advantage for CORI showed that CORI improved skills as well as higher-order strategies in writing.

Math achievement of CORI students was not higher than math achievement of traditional students. This finding provides valuable converging evidence, because math was not included in the objectives of instruction. Since CORI students were higher than traditional students in literacy and science, but not higher in math, the program effects are specific. This finding suggests that the advantage of CORI was not a consequence of higher academic ability, more motivation for schooling, English language competencies, or the characteristics of teachers that were uniquely associated with the CORI classrooms. From this pattern, we infer that it was the CORI program rather than external factors that may be the sources of enhanced achievements.

It should be noted that CORI students surpassed traditional students on the social studies measure in the MSPAP. Although this finding was unexpected, it is not mysterious. Reading and writing were necessary for high scores on the social studies measures. CORI students were taught to handle large texts with multiple interpretation and to compose extended, thoughtful reactions. These competencies were likely to be valuable in the social studies tasks of the performance assessment.

CORI is not a finished product. The nature of the teaching, required materials, professional development activities, administrative supports, and other curricula requirements are yet to be fully determined. Despite the needs for continued improvement, it is plausible to suggest that CORI is likely to enhance achievement in grades 3–6 on broad, integrated performance assessment measures of achievement.

DISCUSSION

This paper was addressed to the broad question of "Does CORI increase motivation, strategies, and conceptual learning?" A variety of researchers, administrators, and teachers have remarked that CORI appears to be an attractive framework for integrating teaching and motivating higher-order learning in literacy and science. In the same breath, these observers often ask whether this CORI increases achievement in comparison to more traditional teaching. To explore this issue, we conducted two quasi-experiments comparing students who received a year of CORI with students who received a year of traditional teaching in literacy and science. In both Study I and II, an extended posttest in the form of a performance assessment, administered in the spring of the academic year, was used to compare achievement of the experimental and comparison students.

In Study I, we introduced statistical controls of literacy level, science background, and topic knowledge on the content of the performance assessment to increase the comparability of the populations. Comparisons showed advantages for CORI. As Figures 2 and 3 show, third-grade students in the CORI program had higher performance on measures of engagement and conceptual learning than third-grade students in the traditional classroom program. Likewise, fifth-grade CORI students had higher levels of literacy engagement and conceptual learning than fifth-grade traditional students.

We observed an additional, unexpected finding. Students in third grade who received CORI showed higher achievement than students in fifth grade who participated in a traditional teaching program. This advantage for CORI appeared for literacy engagement, which we defined as the motivated use of cognitive strategies for learning science concepts. In Study I, the search score on the performance assessment was used as the indicator of literacy engagement. High search scores indicated that students located appropriate text, extracted relevant information from these texts, and persisted in elaborating their understanding of the conceptual topic.

The relatively high performance of CORI third-grade in comparison to traditional fifth-grade students was also observed in conceptual learning. Students were more able to marshal relevant facts, provide cogent explanations, and link concepts theoretically if they participated in CORI. It should be noted that these inferences are possible only if the students at grades 3 and 5 are placed on the same scale with the same performance assessment. In this study, the performance assessment with texts, tasks, writing expectations, and prompts provided a learning and testing environment that was equitable for students in both programs at both grade levels. Students in traditional teaching, as well as CORI, were being taught similar science contents and science processes.

An alternative framework for showing the findings of Study I is presented in Figure 1. Combining the results from all of the students, it shows that conceptual learning was substantially increased by motivated use of cognitive strategies. Students who became more fully engaged in learning science from studying multiple texts, attained higher levels of science knowledge than students who were less engaged. In addition, Figure 1 depicts that students who received CORI increased in literacy engagement more than students who did not receive CORI. The principles of CORI appear to enhance cognitive competence and motivational dispositions for higher-order learning. These capabilities were transferred from the curriculum of the school year to the performance assessment context. These findings, it should be noted, were maintained when student background variables of literacy levels, science knowledge, and topic knowledge were held constant statistically.

An intriguing finding was that CORI enhanced conceptual learning above and beyond its influence on literacy engagement. CORI students were more successful than traditional students in integrating their thinking, writing cogently, and providing full, theoretical explanations of the topic. Not only did they search more efficiently and display intrinsic motivations for learning during the search activity, they were able to use the information gleaned in their search to write more integratively than traditional students. Another way of stating this finding is to say that although a substantial proportion of the effects of CORI on conceptual learning were mediated through literacy engagement, some benefits of CORI on conceptual learning were direct.

In Study II, we found that CORI students were higher than traditional students on the literacy and science sections of the Maryland School Performance Assessment. This finding adds credence to the results of Study I. Because CORI students did not achieve higher scores in areas that were not taught (e.g., math), the achievement differences seem attributable to effects of the instructional program rather than student background or teacher characteristics. Although Study II did not statistically control background variables as Study I did, the convergence of results in the two investigations tends to confirm the effectiveness of the instructional program for enhancing literacy engagement and conceptual learning.

How does CORI compare with other forms of integrated teaching designed to increase conceptual learning? Integrated teaching is increasingly popular in schools. A large proportion of language arts teachers are connecting the reading, writing, speaking, listening, and communications in language arts instruction. Many teachers are also integrating disciplines with each other. For example, language arts and history are often linked around topical themes; science and language arts are taught in conjunction by emphasizing reading and writing in expository texts and trade books along with "hands-on" science activities (Saul et al., 1993). Full integrations of science, history, English/language arts, math, and geography are occasionally attempted (Beane, 1995). Although a variety of instructional integrations are being implemented (Stephenson & Carr, 1993), relatively few attempts have been made to describe them thoroughly and even fewer attempts have been made to examine the impacts of integrated teaching on student learning.

At least three distinct forms of integrated teaching can be compared with CORI. In the project-based approach, teachers help students to form a thematic learning goal (Blumenfeld, Soloway, & Marx, 1991). Students engage in high amounts of self-directed activity in small groups and individually to attain the goal. A prominent aim within the project-based approach is to construct an artifact that embodies the knowledge gained in the project. The artifact may be a diorama, a model, or a depiction of relationships in the form of a poster or video. CORI is contrasted from project-based teaching because the basic aim in CORI is conceptual. In CORI, the artifact in the form of a poster or video is not considered a major objective, but is considered one of several forms of documenting progress toward the more conceptual aim of the teaching unit.

Integrated teaching described by Brown (1992) is directed to in-depth learning about broad concepts of environmental science (e.g., ecological interdependencies). A major goal of the Brown (1992) program is transfer of conceptual knowledge from the particular topic of instruction to new allied topics. Teachers emphasize collaborative teams with distributed expertise across different members of the team. Although CORI also contains an emphasis on conceptual learning through team-based inquiry, CORI places a higher emphasis on direct strategy instruction, of multiple genre including novels and folktales, and literacy as well as science learning.

Duffy (1993) has designed instruction in strategies for learning substantive content. Instruction in comprehension, integration, and composition was relatively individualized, and cognitive-strategy-centered. In comparison, CORI places relatively more emphasis on conceptual understanding, collaborative interaction, self-expression, and interdisciplinary structure of content.

In conclusion, CORI draws upon the project-based emphasis of Blumenfeld et al. (1991) to underscore the importance of self-directed learning toward intrinsically interesting goals. CORI relates closely to Brown's (1992) emphasis on in-depth conceptual learning as a basis for transfer and problem solving. CORI incorporates the direct coaching of strategies for understanding text and learning science concepts exemplified by Duffy (1993) and Collins-Block (1992). In addition, CORI places a prominence on real-world experience. Hands-on activities are linked to literacy and conceptual goals. Self-expression of conceptual knowledge through informational writing, narrative compositions, video portrayals, posters, and dioramas are explicitly intertwined into the learning experience of students. Finally, the hallmark of CORI is coherence of experience. Students link hands-on experience with text-based knowledge, individual endeavor with collective effort, science explanations with literate tools for inquiry, and school-relevant curricular objectives with personally significant interests. Finding ways to enhance the coherence of the classroom is one of our main, continuing goals for instructional design.

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Appendix

Rubrics for Coding the Performance Assessment

Prior Knowledge

This rubric was the same as the writing rubric.

Writing

Level 1

At this level the students presented: (1) no information; or (2) scientifically inaccurate information; or (3) one appropriately identified feature or specie for each biome; or (4) two features or species for only one of the biomes.

Level 2

Students presented a combination of 2–4 general or specific features of the biomes or species for at least one biome. However, no relationships among them were demonstrated. At this level, students may also present scientifically inaccurate information.

Level 3

At this level, the student may have presented accurate and relevant information for a minimum of four specific features of one biome. An alternative was that students could present any relationships or connections between the species and the features of the biome, but the relationships were implicit through comparison or vague. No explanations for relationship of features are presented.

Level 4

At this level, a student presented all of the necessary elements for a level 3, but the relationships or connections between species and the features of the biome were presented explicitly. However, these relations were stated for only one biome and the other remains implicit or vague. Students may also present their answer in the form of a clear relationship in one biome that was not trans ferrable to the other. Explanations were explicitly included and were distinguishable from particular facts or statements of biome and species characteristics.

Level 5

At this level, students wrote an explicit relationship between species and features for both biomes. The comparison was often parallel, with one type of animal in one biome comparable to a type of animal in the other biome showing asymmetry. However, answers at this level lack connections between the relationships between the species and features. An alternative means for obtaining a level 5 was to present a systemic (level 6) response for only one biome with very limited information on a second biome.

Level 6

At this level, students clearly explicated the principles that link the features of biomes in terms of "systems." For example, life cycles or adaptations of certain species and the relationships of these species and features of their respective biomes were stated. The systems are governed by principles centered around the availability of water, temperature, formations of the biome, survival, or food chains.

Drawing

This rubric was the same as the writing rubric.

Search

The rubric for search consisted of six levels. Several aspects of the log were incorporated into the final reading including the number of relevant packets chosen by the students, the quality of the notes evidenced in the log, and the characteristics of the reasons given for choosing the packets. Students' motivational characteristics such as elaboration, persistence, and apparent interest in task were recognized.

Level 1 was assigned to student work in which responses were nonexistent, incoherent, or completely irrelevant to the question. Reasons for choosing the packet were not presented.

Level 2 was assigned to responses in which students reported 1–3 relevant packets. The notes however, showed vague information related to one plant or animal. Reasons for choosing the notes were excluded or were self-referenced (such as, "I liked it").

Level 3 was assigned to responses in which 3–5 relevant packets were selected and several irrelevant packets (1–3) may have been included. Notes appeared in the form of "captions" or titles and headings. Usually 3–6 features or species were listed and a number of these features may be scientifically trivial. One packet usually showed the notes that reflected a written reason for choosing them. However, the links between notes and packets were otherwise missing, incoherent, or repetitive.

Level 4 consisted of 2–5 relevant packets. From these a substantial number of appropriate structures (3–15) for each biome was identified including plants, animals, weather, and soil of each biome.

Level 5 was assigned to responses in which 4–7 relevant packets were selected. The key structures of both biomes of pond and desert were included and a few simple relations between particular animals or between specific plants and biome features were expressed.

Level 6 consisted of 4–7 relevant packets with an explicit reason for them. The notes illustrated the principle of adaptation for both plants and animals. At this level, life cycles of plants and animals are shown be related to the features of biomes. The sequence of packets selected during the search showed cumulative development of biome and adaptive information about plants and animals. The notes may have possessed the quality of "argument" if information is combined with reasoning to present a cogent viewpoint. The notes consistently contain information that fulfills the goal stated in the reason.

The *reasons* for choosing packets were coded separately and combined with the initial levels assigned to packet selection and quality of the notes.

Reasons at Level 1 were not presented or were not distinct from notes.

Reasons at Level 3 were distinct from notes but were not topical or conceptual (e.g., "it was interesting"). Reasons were not associated or connected to the content of the notes.

Reasons at Level 5 consisted of 4–7 reasons stated distinctly from the notes. However, the reasons were too general or too specific although they were related to the content of the notes for a majority of the packets.

At Level 6, 5–9 reasons were presented. These reasons consisted of a goal for reading that was at least as specific as the title for a major heading of the text, but was not a verbatim repetition. Reasons were presented in a definable sequence and related to the notes.

These levels of supplying reasons for choosing information were related to the initial coding. Having identified the rubric level based on selections and notes the coder then adjusted the level based on the coding for reasons according to the following table:

Selection and Notes	Reasons	Final Code
7,6	5 or 7	no change
7,6	3 or 1	reduce 1
5,4	7 or 5	no change
5,4	3	reduce 1
5,4	1	reduce 2
3,2	3 or 5	no change
3,2	1	reduce 1
1	1,3 or 5	no change

Transfer

This rubric was the same as the writing rubric.

Information Text Comprehension

Each question in this section was scored on a three-point scale (1–3). The scores range from 4–12. The general standards for each answer consisted of the following:

1. Inaccurate or an incoherent answer; the answer did not demonstrate an understanding of the question or the text.
2. Accurate response demonstrating an understanding of either of the text or the question.
3. Accurate and elaborated response demonstrating a complete understanding of both the text and the question.

These expectations were applied to both grade-3 and grade-5 responses. For grade 3, Level 1 responses were consistently incoherent or irrelevant to the question. For grade 5, Level 1 responses were incoherent, inaccurate, or extremely vague and general with one or two remotely relevant pieces of information.

Level 2 responses for grade 3 included a few important bits of information from the text and one relevant point that addressed the question. For grade 5, Level 2 responses included a portion but not all of the text-based information needed in the question. Relations between information and explanations were absent or weakly stated.

Level 3 responses for third-grade included essential concepts, accurate information, and a completeness of description. For grade 5, Level 3 responses contained full descriptions with relations among concepts clearly defined. Explanations were provided if requested in the question. The response contained critical details and elaborated statements of their relationships to each other.

Narrative Interpretation

The three questions in the narrative assessment task were each coded on three levels. This provided a score of 3–9 on the narrative task for each student.

At Level 1, the students provided an irrelevant answer, an incoherent brief statement, no answer, or a self-reference but not a text-reference response.

Level 2 responses for grade-3 and grade-5 students included appropriate information that was vague, limited in scope, and/or marginally appropriate to the question. Level 3 responses for grade-3 and grade-5 students included elaborate descriptions that were question-relevant and text-based. These students supported a general point with specific examples from the text and replied to all parts of the question.

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